

MULTIMEDIA



UNIVERSITY

STUDENT ID NO

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# MULTIMEDIA UNIVERSITY

MASTER OF ELECTRICAL AND ELECTRONIC ENGINEERING

MODULE 21000 FINAL EXAMINATION, SESSION 2016/2017

## EEE7216 – ENGINEERING OPTIMIZATION

(All sections/Groups)

1 JUNE 2017  
2:00 P.M- 5:00 P.M  
(3 Hours)

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### INSTRUCTION TO STUDENT

1. This question paper consists of 7 pages only (including this page).
2. Attempt ALL **FOUR** questions. All questions carry equal marks (25 marks) and the distribution of the marks for each question is given.
3. Please print all your answers in the Answer Booklet provided. Please submit the softcopy of the report generated by Excel Solver as well.

**Question 1**

- (a) As an engineering manager, you are in charge of organizing the serving schedule for the technicians to maintain the machinery and equipment of the production plant in East Wing and West Wing.

The need of such service fluctuates by day. At the East Wing production plant, the minimum number of technicians needed is 10 for Monday, 18 for Tuesday, 25 for Wednesday, 18 for Thursday and 10 for Friday. Whereas, the production plant in West Wing operates 7 days a week. The number of technicians required at West Wing production plant are 15, 17, 20, 25, 20, 15 and 18 for Monday, Tuesday, Wednesday, Thursday, Friday, Saturday and Sunday, respectively.

Each technician can start his/her work on any day in a week and works 5 consecutive days, followed by two consecutive off-days. There is no restriction that the technician has to work at one production plant only, he/she can support the servicing work either at East Wing or West Wing during his/her five working days. However, he/her can only work at one plant each day.

Determine the minimum number of technicians that your department should employ. Formulate this problem as a linear programming problem. (**Do Not** solve the problem). [10 marks]

- (b) Consider the linear programming problem:

$$\text{Maximize } z = 2x + y$$

subject to:

$$5x + 2y \leq 20$$

$$x + y \leq 7$$

$$x, y \geq 0$$

- (i) By using the graphical method, solve the above linear programming problem. [5 marks]
- (ii) By introducing the slack variables, write down the standard linear programming model. [2 marks]
- (iii) Identify the basic variables and the non-basic variables for each corner point of the feasible region. [4 marks]
- (iv) If Simplex method is used to solve the problem, give the order of the corner points that will be visited by Simplex method at each iteration. [2 marks]
- (v) If the objective is to be changed to the form of  $z = c_1x_1 + c_2x_2$ , give the ratio of  $\frac{c_1}{c_2}$  such that the optimal solution remains unchanged. [2 marks]

**Continued...**

## Question 2

Delta Engineering Sdn. Bhd. manufactures four types of electric motors, each on separate assembly line; Motor I, Motor II, Motor III and Motor IV are produced at Assembly Line I, Assembly Line II, Assembly Line III and Assembly Line IV, respectively. The respective daily capacity of the assembly line is 60, 110, 150 and 100. The production process required three types of resources: resistor, capacitor and chips. The following table gives the availability of the resources and their usage by the four products, as well as the prices per unit of motor (in \$1000).

Resource	Resource requirement per unit				Daily availability
	Motor I	Motor II	Motor III	Motor IV	
Resistor	3	2	3	5	1300
Capacitor	4	2	4	3	1500
Chips	1	4	1	2	1000
Price (In \$1000)	5	4	6	7	

In order to determine the optimal product mix, the following linear programming problem has been formulated:

$$\text{Maximize } z = 5x_1 + 4x_2 + 6x_3 + 7x_4 \text{ (in \$1000)}$$

subject to:

$$\begin{aligned}
 x_1 &\leq 60 && \text{(Plant I capacity)} \\
 x_2 &\leq 110 && \text{(Plant II capacity)} \\
 x_3 &\leq 150 && \text{(Plant III capacity)} \\
 x_4 &\leq 100 && \text{(Plant IV capacity)} \\
 3x_1 + 2x_2 + 3x_3 + 5x_4 &\leq 1300 && \text{(Resistor)} \\
 4x_1 + 2x_2 + 4x_3 + 3x_4 &\leq 1500 && \text{(Capacitor)} \\
 x_1 + 4x_2 + x_3 + 2x_4 &\leq 1000 && \text{(Chips)} \\
 x_1, x_2, x_3, x_4 &\geq 0
 \end{aligned}$$

where  $x_1, x_2, x_3$  and  $x_4$  are the daily product level of Motor I, Motor II, Motor III and Motor IV, respectively.

- Use Excel Solver to determine the daily production figure for each plant. [5 marks]
- Generate the sensitivity report by using the Excel Solver. Write a report to the management level. Include the following points in your discussion.
  - shadow price for each plant capacity and resources
  - unused plant capacity and resources
  - feasibility range of each plant capacity and resources
  - optimality range of each plant capacity and resources

[8 marks]

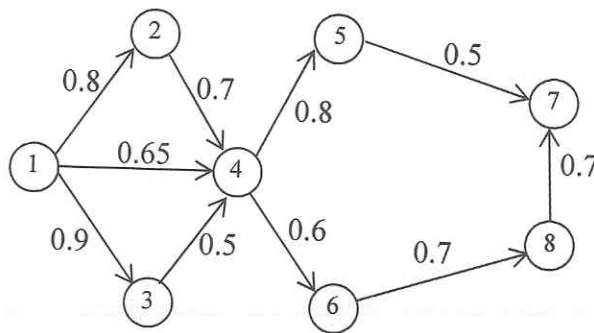
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In your report, include the answers to the following questions. Justify each of your answers.

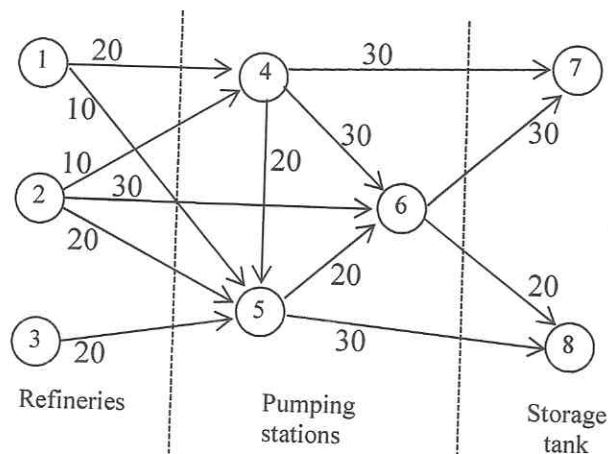
- (i) Which plant capacity is full, and which plant should receive higher priority in capacity expansion? [2 marks]
- (ii) The plant capacity can be increased by engaging the workers to work overtime. what is maximum cost the management should pay for overtime? [2 marks]
- (iii) A suggestion is made to increase the availability of all the materials. Is this advisable? [2 marks]
- (iv) If the resistors availability is increased from the present 1300 units to 1330 units at a cost of \$1200 per unit, how will this increase impact to the optimum profit? [2 marks]
- (v) For marketing reason, the price for Motor III must be reduced to \$4000 per unit, will the current optimum solution on production mix change? [2 marks]
- (vi) If the unit price for motor are each reduced by 10%, what will be the new total profit? [2 marks]

**Question 3**

- (a) Consider the following graph. The vertices of the graph represent the communication terminals, the edges represent feasible connection between terminals. The probability that a link will operate without failure is shown next to the edge.



- (i) If the objective is to determine the route that will maximize the probability of successful transmission of messages from terminal 1 to terminal 7, formulate the situation as a “shortest-route problem”. Which algorithm can be used to design such communication network? Give reason to your answer. [3 marks]
- (ii) Hence, use the suggested algorithm to solve the problem. [9 marks]
- (b) In a chemical substances manufacturing line, three refineries send the chemical products to two storage tanks through a pipelines network. The pipelines network consists of three pumping stations as shown below.



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The flow direction in the network is indicated by the arrow, and the capacity of each pipe segment in million liters per day is shown beside the link.

- (i) Formulate a linear programming problem to determine the maximal daily production at each refinery subject to the maximum capacity of the network. [4 marks]
- (ii) Solve the linear programming problem using Excel Solver. Give the maximal daily production at each refinery that matches the maximum capacity of the network. Hence, identify the amount of flow at each pump station. [7 marks]
- (iii) Can the network flow be increased by expanding the capacities in the direction 5 to 6, and 4 to 7? Justify your answer. [2 marks]

#### Question 4

- (a) You use a single machine to process four jobs, and two jobs cannot be processed concurrently. The following table provides processing time and due date. All times are in days and due time is measured from time 0, the assumed start time of the first job.

Job	Processing time (days)	Due date from time 0 (days)
1	22	44
2	9	30
3	10	20
4	12	35

The objective is to process all the jobs with minimal sum of due date.

- (i) Formulate the problem as an integer linear programming problem (**DO NOT** solve the problem). [5 marks]
- (ii) Suppose that job 4 cannot be processed until job 3 has been completed. How would this condition affect the model in part (i). (**DO NOT** solve the problem). [2 marks]

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- (c) Consider the following mixed integer programming problem:

$$\text{Maximize } z = 2x_1 + 4x_2 + 3x_3$$

subject to :

$$3x_1 + 4x_2 + 2x_3 \leq 50$$

$$2x_1 + x_2 + 2x_3 \leq 40$$

$$x_1, x_2, x_3 \geq 0 \text{ and } x_1, x_2, x_3 \text{ are integrals.}$$

Apply the branch-and-bound procedure to solve the above problem. Solve each relaxation of linear-programming problem encountered by using Excel Solver. Interpret the branch-and-bound procedure using network.

[10 marks]

- (d) Use the Golden section method with an error tolerance  $\epsilon = 0.01$  and initial bound  $x = 0$  and  $x = 0.5$  to approximate the optimal solution of the following problem:

$$\text{Maximize } z = \sqrt{2x} - x^2, \quad 0.4 \leq x \leq 0.6$$

Is the optimal solution obtained a global maximum or a local maximum? Justify your answer.

[8 marks]

**End of Paper.**